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Description of the male of *Xystromutilla bucki* Suárez, 1960 (Hymenoptera, Mutillidae), including new information on the biology of the genus

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Abstract

The male of *Xystromutilla bucki* Suárez, 1960 is described and associated with the female based on couples reared from trap-nests occupied by *Auplopus subaurarius* Dreisbach, 1963 (Hymenoptera: Pompilidae). Information on the diapause of *X. bucki* and *Pseudomethoca* nr. *chontalensis* (Cameron, 1895) (Hymenoptera: Mutillidae) is presented. Seasonal and annual variation in the abundance of *X. turrialba* Casal, 1969 are also given.

Keywords

Auplopus, diapause, Neotropical, Pepsinae, *Pseudomethoca*, seasonal abundance, Sphaeropthalminae, spider wasps, velvet ants

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Introduction

Xystromutilla André, 1905 (Mutillidae: Sphaeropthalminae) belongs to the tribe Sphaeropthalmini (Brothers and Lelej 2017). This Neotropical genus has 14 described species (Bartholomay et al. 2019; Pagliano et al. 2020), two from Central America and 12 from South America, with only *X. turrialba* Casal, 1969 and *X. carpenteri* Cambra & Quintero, 2004 known from both sexes (Cambra and Quintero 2004). Morato (1994) mentioned rearing male and female specimens of *X. asperiventris* André, 1905 from the same trap nests, but this male has not yet been described, although specimens were used by Brothers and Lelej (2017) in compiling the characters of *Xystromutilla*.

Four species of *Xystromutilla* have known hosts; three of these attack solitary aculeate wasps and one attacks a solitary bee. André (1906) mentioned a specimen of *X. aequatorialis* (André, 1906) with a label indicating it was a parasite of *Melitoma taurea* (Say) (as *Entechnia taurea* Say). Morato (1994) reared *X. asperiventris* André, 1905 from *Trypoxylon* (*Trypoxylon*) *nitidum* F. Smith, 1856, *Trypoxylon* (*Trypargilum*) *lactitarse* de Saussure, 1867, *Trypoxylon* aff. *unguicorne* Richards, 1934 (Crabronidae), and *Podium rufipes* Fabricius, 1804 (Sphecidae); Rodríguez and Matías (1996) recorded *X. turrialba* from *Trypoxylon* sp. and *Podium* sp.; and Cambra and Quintero (2004) mentioned that *X. hansoni* Cambra & Quintero, 2004 was reared from a species of Eumeninae (Vespidae).

In this paper, we present the male description and host association for *X. bucki* Suárez, 1960. Information on diapause for Neotropical Mutillidae is provided, as well as seasonal and annual variation in the abundance of *X. turrialba*.

Materials and methods

The study of *Xystromutilla bucki* Suárez, 1960 was carried out from August 2018 to August 2019 in the municipality of Guarapuava, state of Paraná (PR), southern Brazil. Information on the study site and sampling methods with trap-nests were discussed in Cambra et al. (2017).

The study site for flight seasonality of *Xystromutilla turrialba* Casal, 1969 was the field station of the Smithsonian Tropical Research Institute (**STRI**) on Barro Colorado Island (BCI). Information on the study site and sampling methods with Malaise traps were discussed in Cambra et al. (2018).

Photographs of genitalia were made with an Olympus Stylus digital camera using an Olympus BX53F stereomicroscope, with further image processing done using ArcSoft PhotoStudio. The genitalia were stored in a glass vial and placed on the specimen pin. Measurements of the male specimen were made with a calibrated micrometer scale attached to an ocular lens of the stereomicroscope.

The specimens of *Xystromutilla bucki* were identified by authors K.A.W., P.R.B. and R.A.C., while the specimens of *Auplopus subaurarius* Dreisbach, 1963 by R.A.C. and Eduardo Fernando dos Santos. The specimens examined are deposited in Museo de Invertebrados G. B. Fairchild, University of Panama, Panama (**MIUP**) and in the

entomological collection of Laboratório de Biologia e Ecologia de Vespas e Abelhas, Universidade Estadual do Centro-Oeste, Guarapuava (PR), Brazil (UNICENTRO). The specimens of *Pseudomethoca* nr. *chontalensis* are deposited in Museo de Zoología, Universidad de Costa Rica, San José, Costa Rica (**MZUCR**).

Results

Taxonomy

***Xystromutilla bucki* Suárez, 1960**
Figs 1–8

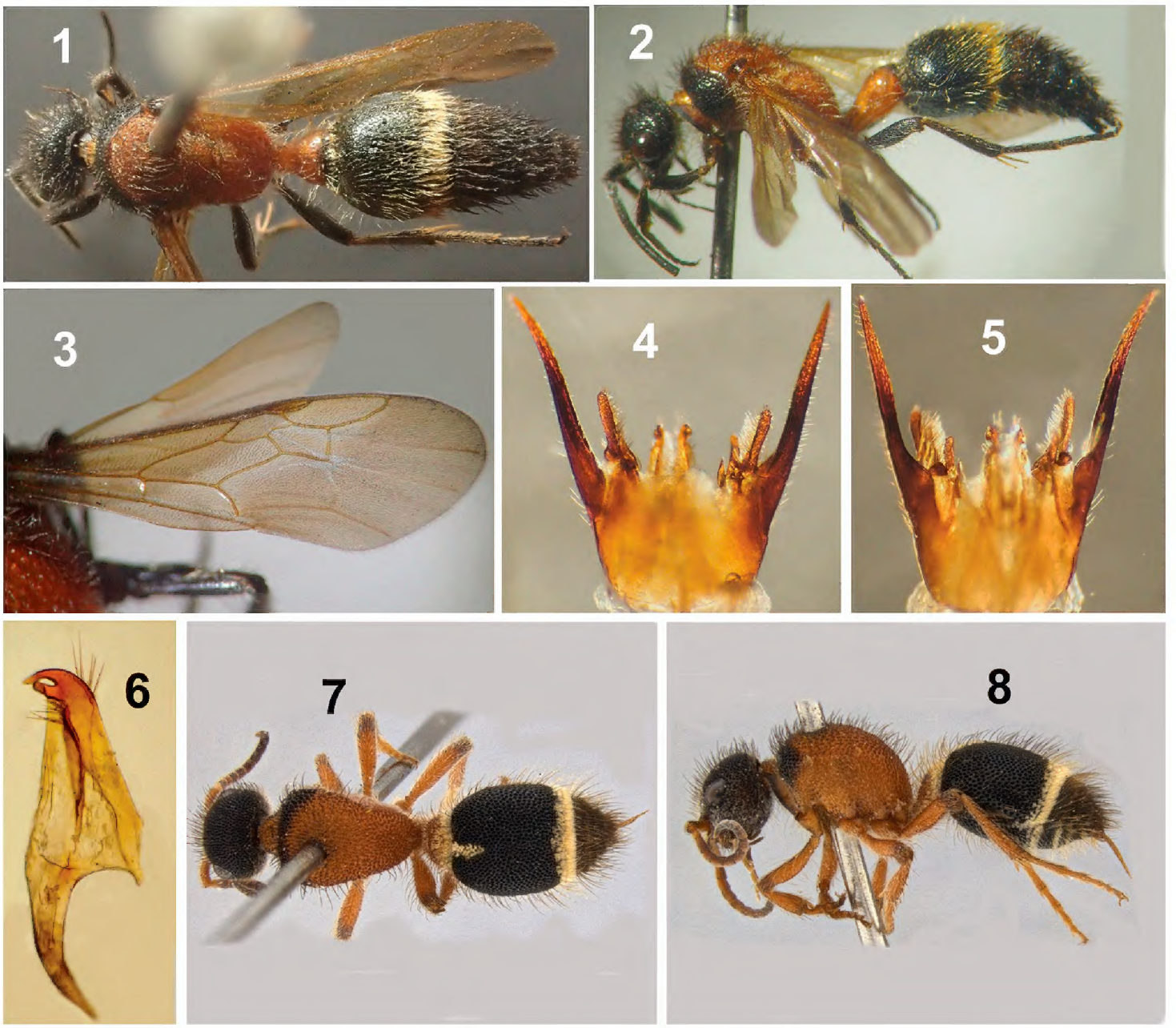
Xystromutilla bucki Suárez, 1960: 453–455, ♀, holotype, Porto Alegre, [Rio Grande do Sul], Brasil, 19.iii.1952, P. Buck (Colección Suárez; now in Museo Nacional de Ciencias Naturales, Madrid, Spain).

Diagnosis. Male (Figs 1–6). This species can be recognized by its unique coloration, wherein the meso-metathorax, propodeum and first metasomal segment are orange-red; wings subhyaline. The following morphological characters are also useful for diagnosis: head with simple setae; mandible ventrally with a strong basal tooth; sternum 1 without a spine; hypopygium posterior margin with a small denticle medially; paramere almost straight and cuspis finger-shaped. Other described males of *Xystromutilla* have black integument, fore wings partly or totally fuscous, sternum 1 with a basal spine, hypopygium with medial spine on the apical margin, paramere lyre-shaped and cuspis elongate spoon-shaped. These morphological characters are not present in males of *X. bucki*. **Female** (Figs 7, 8). Head, pronotum and metasomal segment 1 orange-red, rest of metasoma black; head with simple setae only; humeral angles of pronotum rounded, not carinate; integument of basal half of tergum 2 without carinae.

Description. Male (hitherto unknown). (Figs 1, 2). ***Body length.*** 10.1 mm.

Body Color. Integument black, except apical half of mandible, meso-metathorax, propodeum and first metasomal segment orange-red; tibial spurs white; wings subhyaline, without infuscated area; head, pronotum, mesoscutum and scutellum with long, semierect simple black setae; meso-metapleura and propodeum mostly with long, semierect simple pale white setae; fore legs mostly with simple black setae, mid and hind legs mostly with simple pale white setae and few black setae; metasomal segments one and two with long semierect simple pale white setae, posterior margin of metasomal segment 2 with dense and decumbent band of plumose white setae; metasomal segments 3 to 7 with long, semierect black setae, posterior margins of metasomal segments 3 and 4 with decumbent plumose black setae mostly hidden by simple setae.

Head. Rectangular in dorsal view, frons, vertex and gena with medium-sized, very close punctures; distance between eye margin and lateral ocellus 2.77 × as long as diameter of ocellus; flagellomere I 1.9 × pedicel length; flagellomere II 2.2 × pedicel



Figures 1–8. *Xystromutilla bucki* **1–6** male: **1** dorsal view **2** lateral view **3** right wings **4** genitalia, dorsal view **5** genitalia, ventral view **6** penis valve, lateral view **7, 8** female: **7** dorsal view **8** lateral view.

length; clypeus bidentate medially on anterior margin; mandible apically obliquely tridentate, ventrally with a strong tooth near base.

Mesosoma. Pronotum, mesoscutum, scutellum and mesopleuron with medium-sized, contiguous punctures, metapleuron impunctate; tegula glabrous, except anterior and inner margins setigerously punctate; propodeum totally reticulate; notaulus incomplete, not reaching anterior margin of mesoscutum; scutellum convex; fore wing (Fig. 3) with two submarginal cells; coxae without denticle, tubercle or carina.

Metasoma. First segment petiolate, tergum 1 dorsal face 1.47 × as long as wide; tergum 1–2 and sternum 2 and 7 mostly with medium-sized close punctures; metasomal segments 3–6 with small, close punctures; tergum 7 basal half with small punctures, apical half mostly without punctures; sternum 1 without a spine near base, with two longitudinal carinae diverging posteriorly; hypopygium posterior margin not straight, with a small denticle medially.

Genitalia. Parameres (Figs 4, 5) almost straight, not lyre-shaped; basal half in lateral view broad, distal half gradually narrowing toward apex and slightly curved upwards, ending in a sharp point; dorsal surface with five long setae at end of basal broad

half; very short sparse setae elsewhere; digitus and cuspis (Figs 4, 5) finger-shaped, digitus with inconspicuous and sparse setae, cuspis laterally flattened with dense long setae on inner surface; penial valve (Fig. 6) with an apical tooth and preapical projection with blunt apex, apical dorsal edge with five long setae and near to base of preapical projection with six long setae.

Material examined. Brazil: **Santa Catarina:** Porto União, nest 371 (1) (5 mm hole diameter), 13.i.2012–14.ii.2012, J. Iantas, 1 ♀ (MIUP) (reared from nest of *Auplopus subaurarius* Dreisbach, 1963). **Rio Grande do Sul:** Cambara do Sul, Itaimbezinho, 10.iii.2000, col. R. da Cunha, 1 ♀ (MIUP); Guaiba, 116 – km 307, col. F.V. Borges: 15.i.1998, 1 ♂ (MIUP); 30.ix.1999, 1 ♂ (MIUP); São Francisco de Paula, CPCN Pro-Mata, col. B. Harter: 4.viii.1997, 1 ♂ (MIUP); 6.i.1998, 1 ♂ (MIUP). **Paraná:** Turvo, 25°01'55"S, 51°31'53"W, col. M.C. Nether: 22.xii.2012, 2 ♂ (nest 223) (MIUP); 22.ii.2013, 1 ♂ (nest 552) (MIUP); Guarapuava, 25°21'55"S, 51°27'58"W, 24.i.2013, col M.C. Nether, 1 ♂ (nest 447) (MIUP); Guarapuava, 25°24'09.7"S, 51°24'45.5"W, 11.iii.2019, col. C. Queiros and J. De Deus, 6 ♂, 1 ♀ (nests 353, 460) (UNICENTRO); Guarapuava, 25°39'S, 51°42'W, 10.v.2019, col. C. Queiros and J. De Deus, 1 ♀ (nest 365) (UNICENTRO)

Distribution. Brazil (Paraná, Rio Grande do Sul, Santa Catarina).

Biology. This is the first record of Pompilidae as a host of *Xystromutilla*. In the Araucaria forest fragments, 66 trap-nests of *Auplopus subaurarius* Dreisbach were examined. Of these nests, *X. bucki* parasitized three of them, all of which were in bamboo, 1.3 cm in diameter and 18.2 cm in length. One of the nests had nine cells, six of which were parasitized by *Xystromutilla* (five males and one female emerged) and two by *Photocryptus* sp. (Ichneumonidae: Cryptinae). The other two parasitized nests contained one cell each, from which emerged a male and a female. Therefore, six males and two females emerged in total from the nests. The males were larger bodied with average head width 0.3 mm (n = 6; SD = 0.01 mm) and the females 0.2 mm (n = 2; SD = 0.06 mm).

We found in *Xystromutilla bucki* that the average time between nest collection and adult wasp emergence, for seven of the eight specimens reared, was 265 days (n = 7; SD = 4.2 days), with immatures exhibiting diapause at the prepupal stage (6 males, 1 female). Only one female (from the one-celled nest) did not enter into diapause, but rather emerged 11 days after nest collection.

Xystromutilla turrialba Casal, 1969

Xystromutilla turrialba Casal, 1969, Physis 29: 47, holotype female, Turrialba, Costa Rica, USNM.

Material examined. (81 specimens, MIUP): Panamá, Barro Colorado Island: iv.2001, 15 males; v.2001, 5 males; v.2002, 2 males; vi.2002, 5 males; vii.2002, 1 male; iii.2003, 14 males, 1 female; iv.2003, 27 males, 1 female; v.2003, 5 males; ii.2004, 2 males; iv.2004, 2 males; v.2004, 1 male.

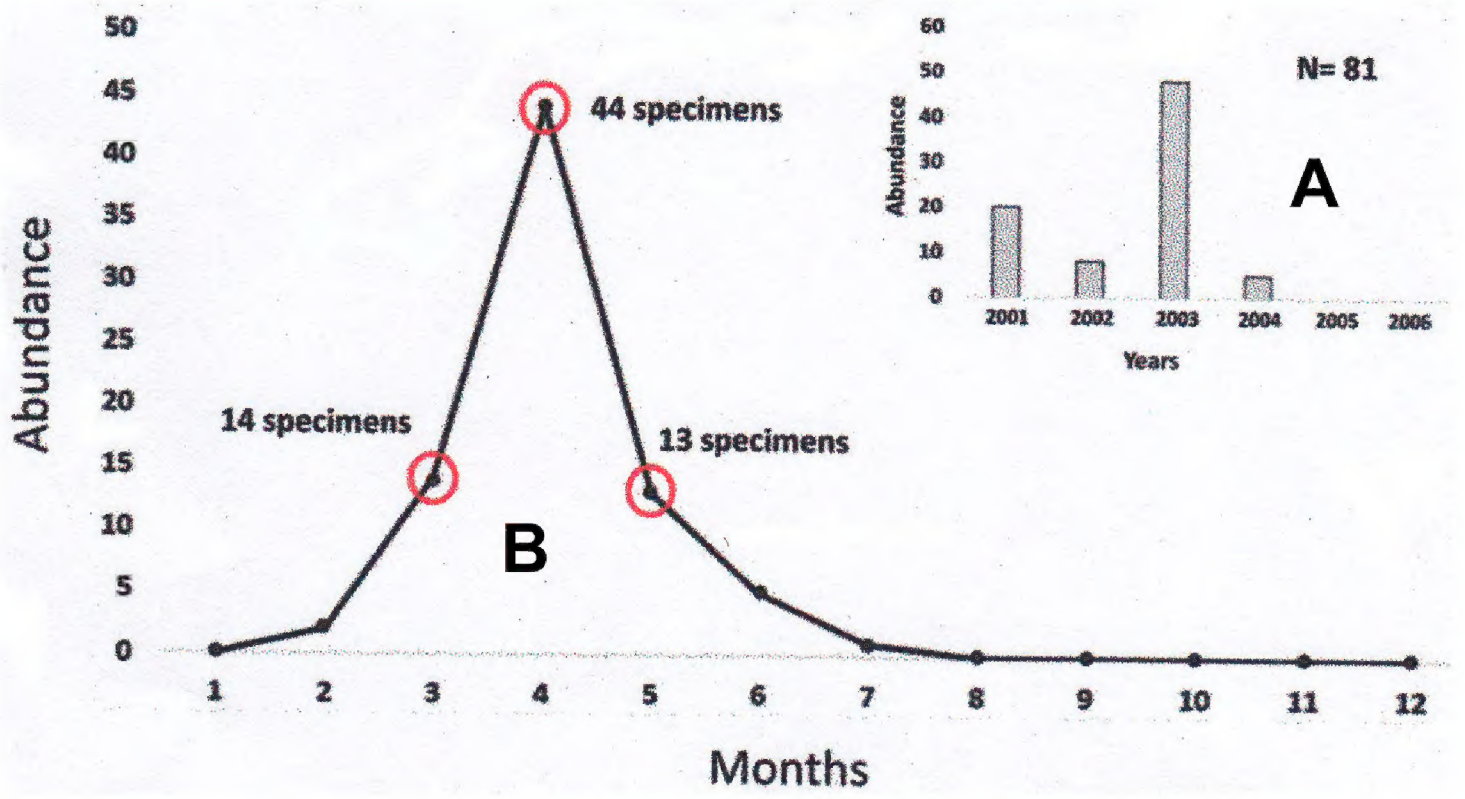


Figure 9. A total *Xystromutilla turrialba* specimens captured by year (2001–2006) **B** total *Xystromutilla turrialba* specimens captured by month (2001–2006).

Distribution. Honduras, Nicaragua, Costa Rica, Panama (Casal 1969; Cambra and Quintero 2004).

Seasonal and annual abundance. A total of 81 specimens of *Xystromutilla turrialba* (79 males and 2 females) were captured over six continuous sampling years (2001–2006) with ten Malaise traps on Barro Colorado Island (BCI), Panama. The years with the greatest abundance of specimens were 2001 and 2003; samples were not captured during 2005 and 2006 (Fig. 9A). Specimens of *X. turrialba* were captured only in the months from February to July, with greatest abundance from March to May with 71 (87.6%) specimens captured, peaking during April with 44 specimens (54.3%) (Fig. 9B). The greater abundance of *X. turrialba* during April is similar to results found for *Dasymutilla* Ashmead, 1899 and *Ephuta* Say, 1836 (Mutillidae) species on BCI (Cambra et al. 2018; Añino et al. 2020). The only two females of *X. turrialba* were captured in March and April, and their relatively small number compared to that of males on BCI is due to the sampling methodology, since females are apterous. The under-representation of females is not seen in hand-net and trap-nest samples from Panama, in which 14 females and 16 males of *X. turrialba* were captured during all months of the year except November (Cambra and Quintero 1992, 2004).

Discussion

Both sexes of *Xystromutilla bucki* are morphologically similar to some species of the genus *Sphaeropthalma* Blake, 1871, especially those recorded from Central and South America (Williams and Pitts 2007). Brothers (2006) presented a key for the Neotropi-

cal genera of Mutillidae, placing both *Xystromutilla* and *Sphaeropthalma* in the same couplet and separating them based on the presence or absence of plumose setae on the head, as well as the shape of the first metasomal tergum. It is important to note that *Sphaeropthalma* is a sort of "dumping ground" genus for nocturnal species of velvet ants in South America and many of its species will likely be placed in different genera in the future (KAW, PRB and RAC, pers. obs.). Sexual associations are of great importance to understand the phylogenetic relationships of *Xystromutilla*, *Sphaeropthalma* and any other genera to be dismembered from the latter, as well as to have a better knowledge of the morphological characteristics that delimit Sphaeropthalmini genera in the New World.

Little information exists on overwintering/diapause in Mutillidae. Mickel (1928) summarized earlier information from several sources in compiling a typical mutillid life history and stated that "in colder latitudes the winter is passed in the prepupal stage". Bohart and McSwain (1939) mentioned prepupal overwintering for *Dasymutilla sackenii* (Cresson, 1865) from California. Brothers (1972, 1978) observed diapause in the fifth larval instar (prepupa) of some *Pseudomethoca frigida* (Smith, 1855) and *Myrmosula parvula* (Fox, 1893) kept in the laboratory. Brothers (1972) also presented a summary of unpublished observations by Cottrell, indicating that some individuals of *Dasymutilla bioculata* (Cresson, 1865) may diapause as prepupae for more than one season. Our finding of prepupal diapause in *Xystromutilla bucki* represents the first record for a Neotropical mutillid species and reinforces the apparently general occurrence of such diapause where environmental conditions are appropriate.

Apart from prepupal diapause, there are a few records of hibernation/diapause by adults. Potts and Smith (1944) recorded hibernation in two adult females of *Dasymutilla aureola pacifica* (Cresson, 1875) from California; Evans and Miller (1970) indicated some degree of overwintering by three adult females (marked the previous summer of 1968) of *D. nigripes* (Fabricius, 1787) collected in the summer of 1969 in Michigan; and Hennessey (2002) recorded overwintering by adult females of *D. nigripes* (Fabricius), *D. vesta* (Cresson, 1865) and *Timulla vagans* (Fabricius, 1798) in a deciduous forest in Maryland. The following observations on *Pseudomethoca* nr. *chontalensis* (Cameron, 1895), det. R. Cambra, by Kenji Nishida (unpublished data) are also relevant here. On January 25, 2015, fifteen adult females of *P.* nr. *chontalensis* (with two dark morphs) were found inside a hollow and dry twig of *Quercus insignis* (Fagaceae) (Figs 10, 11). The twig was found on the ground in a relatively open area of the forest in EBM, Monteverde at 1530 m, Pacific slope, Costa Rica; the weather this time of the year is windy and cold, and the temperature was no higher than 16 °C during the morning or afternoon and 12 °C during the night. The twig on the ground used as 'shelter' was an old, empty, cut-off branch made by a female Cerambycidae (Coleoptera) larva (det. K. Nishida), which had probably eaten much of the interior of the twig. No traces or remains of larvae, prepupae, or pupae of any other insect were found, suggesting that the mutillids did not emerge inside the twig. When the twig was manually opened, the 15 mutillids were observed well grouped, with some on top of the others. Two fell to the ground and escaped into the litter; the other 13 (three

Figures 10, 11. *Pseudomethoca* nr. *chontalensis* inside of hollow *Quercus insignis* twig (manually opened).

groups, of six, four, and three specimens) remained motionless within the twig. On February 5, 2015, all the females began to move and left the twig. The temperature was between 24 and 28 °C. The 13 females remained grouped for 12 days. This immobile aggregation indicates a probable diapause in adult females of *P.* nr. *chontalensis*. Janvier (1933: 283) recorded a single male in the middle of a group of 46 female mutillids captured in Chile (identified as *Dimorphomutilla formosa* Mickel, 1938 by Quintero and Cambra 2001). Janvier did not mention how long they were grouped. We do not know of another record related to possible diapause in adults of Neotropical Mutillidae.

Mutillids are solitary wasps; in tropical forests they are generally widely dispersed. We do not know how *P.* nr. *chontalensis* females would form such an aggregation.

However, females and males of Mutillidae produce sounds that may be species specific (Tschuch 1993; Torrico-Bazoberry and Muñoz 2019). The function of stridulation in mutillids is unclear, although these sounds apparently act as warning/defensive signals (Schmidt and Blum 1977; Masters 1979; Polidori et al. 2012) and/or have roles in intra-specific communication (Bayliss and Brothers 1996; Torrico-Bazoberry and Muñoz 2019), but there is no evidence suggesting that such signals could be used in forming aggregations. Although we cannot definitively know the function of aggregation in *P.* nr. *chontalensis*, we suggest that it is a defensive strategy against potential predators while waiting for favorable environmental conditions for dispersal, mating and host searching activities.

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